Ensemble Kalman filter assimilation of temperature and altimeter data with bias correction and application to seasonal prediction

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Abstract

 To compensate for a poorly known geoid, satellite altimeter data is usually analyzed in terms of anomalies from the time mean record. When such anomalies are assimilated into an ocean model, the bias between the climatologies of the model and data is problematic. An ensemble Kalman filter (EnKF) is modified to account for the presence of a forecast-model bias and applied to the assimilation of TOPEX/Poseidon (T/P) altimeter data. The online bias correction (OBC) algorithm uses the same ensemble of model state vectors to estimate biased-error and unbiased-error covariance matrices. Covariance localization is used but the bias covariances have different localization scales from the unbiased-error covariances, thereby accounting for the fact that the bias in a global ocean model could have much larger spatial scales than the random error.

The method is applied to a 27-layer version of the Poseidon global ocean general circulation model with about 30-million state variables. Experiments in which T/P altimeter anomalies are assimilated show that the OBC reduces the RMS observation minus forecast difference for sea-surface height (SSH) over a similar EnKF run in which OBC is not used. Independent in situ temperature observations show that the temperature field is also improved. When the T/P data and in situ temperature data are assimilated in the same run and the configuration of the ensemble at the end of the run is used to initialize the ocean component of the GMAO coupled forecast model, seasonal SSH hindcasts made with the coupled model are generally better than those initialized with optimal interpolation of temperature observations without altimeter data. The analysis of the corresponding sea-surface temperature hindcasts is not as conclusive.